CLAIMS

1. A closure system with thermochromic tamper-control means, said closure system comprising a thermoplastic polymer matrix into which at least one thermochromic pigment is incorporated the color of which is capable of being irreversibly modified after exposure of at least a part of said closure system to a temperature close to or beyond a threshold temperature, the system being characterized in that said threshold temperature corresponds to the minimum temperature to which the closure system of the invention must be heated to render it sufficiently malleable to be removed then subsequently replaced without, however, causing any damage to said closure system.

2. A closure system according to claim 1, characterized in that the thermochromic pigment is inactive as regards temperature during all of the stages of fabricating the closure system, and is then rendered active by an activation process after producing the closure system.

3. A closure system according to either preceding claim, characterized in that the thermochromic compound is selected from diacetylenic type compounds.

4. A closure system according to any preceding claim, characterized in that before activation, the thermochromic pigment is a compound or a mixture of diacetylenic compounds with general formula (I):

$$R\text{-}C\equiv C\text{-}C\equiv C\text{-}R' \qquad (I)$$

in which R and R', which may be identical or different, independently represent a linear or branched, saturated or completely or partially unsaturated alkyl chain, optionally interrupted by and/or comprising one or more cycles at its end, heterocycles and heteroatoms selected from oxygen, nitrogen, and sulfur, said heteroatoms, which may be bonded together, optionally forming groups

or functions such as ester, amide, ether, carboxyl, hydroxyl, amine, etc, for example, R and R' possibly together forming a cycle with the carbon atoms carrying them.

5. A closure system according to claim 4, characterized in that before activation, the thermochromic pigment is a compound or a mixture of diacetylenic compounds with formula (I) in which R and R' are never simultaneously alkyl groups.

6. A closure system according to claim 5, characterized in that before activation, the thermochromic pigment is selected from pentacosa-10,12-diynoic acid, tricosa-10,12-diynoic acid, 2,4-hexadiyn-1,6-bis(n-hexylurethane), its mixture with 2,4-hexadiyn-1-hexyl-6-pentylurethane in a 90/10 molar proportion, and mixtures of said compounds.

7. A closure system according to any preceding claim, in which the matrix further comprises a polymerization inhibitor (UV absorber, HALS (hindered amine light stabilizer)).

8. A closure system according to any preceding claim, in which the quantity of thermochromic pigment in the closure system is advantageously in the range 0.1% to 10% by weight, and preferably in the range 0.2% to 1.5% by weight.

9. A closure system according to any preceding claim, characterized in that the thermochromic pigment is encapsulated before being incorporated into the matrix.

10. A closure system according to any preceding claim, characterized in that the thermoplastic matrix is selected from polyethylene, polypropylene, their

copolymers, and mixtures of said polymers and/or copolymers.

11. A closure system according to any preceding claim, characterized in that only part of the closure system contains the thermochromic pigment.

12. A closure system according to any preceding claim, characterized in that it can irreversibly change color at a temperature in the range 50°C to 100°C, advantageously in the range 60°C to 100°C, preferably in the range 60°C to 70°C.

13. A closure system according to claim 12, characterized in that the color change occurs a temperature range of 20°C, preferably 10°C, more preferably 1°C or 2°C about the color change zone.

14. A closure system according to any preceding claim, characterized in that the color change occurs in less than 30 s, preferably in less than one second, in the color change temperature range.

15. A closure system according to any preceding claim, characterized in that it further comprises one or more mechanical tamper-control means.

16. A closure system according to claim 15, characterized in that the mechanical tamper-control means is a closure provided with a screw thread and connected to a ring via frangible bridging tabs.

17. The use of at least one thermochromic pigment for the production of a closure system as defined in any one of claims 1 to 16.

18. A use according to claim 17, characterized in that the closure system further comprises a mechanical tamper-control means.

19. A method of preparing a closure system as defined in any one of claims 1 to 16, characterized in that it comprises the steps of:

a) incorporating at least one thermochromic pigment in its inactive form into the polymer matrix of said closure system;

b) forming the closure system; and

c) activating the thermochromic pigment.

20. A method according to claim 19, further comprising a step of crystallizing the pigment after forming the closure system.

21. A method according to claim 19 or claim 20, in which the thermochromic pigment(s) is/are incorporated into the polymer matrix by means of a master mixture which is then mixed with the polymer matrix to produce the closure system.

22. A method according to any one of claims 19 to 21, in which the forming step employs techniques selected from extrusion, injection and injection molding.

23. A method according to any one of claims 19 to 22, in which the closure system is formed by a bi-injection molding technique.

24. A method according to any one of claims 19 to 23, in which the activation step is a high energy photopolymerization step.

25. A method according to any one of claims 19 to 24, in which the activation step is a UV irradiation step.

26. A method of checking for tampering by exposing at least a part of a closure system according to any one of claims 1 to 16, or obtained using the method according to any one of claims 19 to 25, to a temperature close to or above a color change temperature for the thermochromic pigment, characterized in that the color of a reference closure system which has not been exposed to a temperature close to or above the color change temperature of the thermochromic pigment is compared with a closure system which may have been exposed to a temperature close to or above said color change temperature of the thermochromic pigment incorporated into said closure system.

27. A container provided with a closure system according to any one of claims 1 to 16, or obtained using the method of any one of claims 19 to 25.

28. A container according to claim 27, which is a bottle the closure system of which as defined in any one of claims 1 to 16 is of the screw closure type with a ring and frangible bridging tabs.

29. A container according to claim 27 or claim 28, which is a mineral water bottle.